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(56) Documents Cited
JP 090210857 A **JP 080128806 A**

(58) Field of Search
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INT CL^7 **G02F 1/09**
Online: EPODOC; WPI; PAJ

(54) Abstract Title
Optical attenuating isolator

(57) An optical attenuating isolator obtained by combining an optical attenuator and an isolator into a module, is provided. The optical attenuating isolator includes a first collimator, an optical attenuating filter, an isolation unit, and a second collimator. The first collimator is connected to a first optical transmission medium, and collimates light received via the first optical transmission medium. The optical attenuating filter attenuates the output light of the first collimator. The isolation unit receives light attenuated by the optical attenuating filter and passes only polarized light which flows in a predetermined specific polarization direction. The second collimator is connected to a second optical transmission medium, and collimates polarized light which has passed through the isolation unit, and transmits the resultant light to the second optical transmission medium. Accordingly, an optical attenuator and an isolator are configured into a module, such that insertion loss can be reduced, and that the number of optical transmission media used is reduced, thus preventing generation of loss caused by the optical transmission media. Also, an optical attenuating isolator according to the present invention is used as an optical attenuator for an optical communications system having directivity, such that deterioration of the optical communications system due to back reflection can be prevented, and that the degree of attenuation can be controlled.

FIG. 3

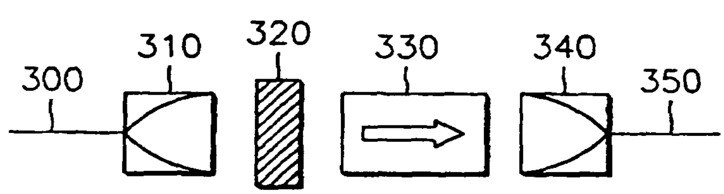

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FIG. 1

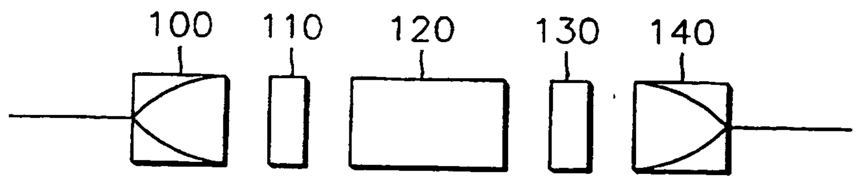


FIG. 2

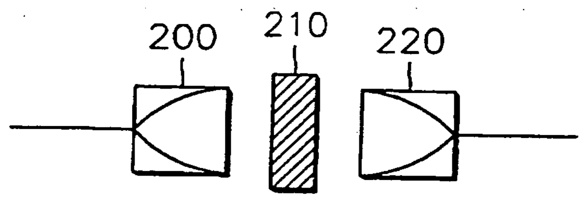


FIG. 3

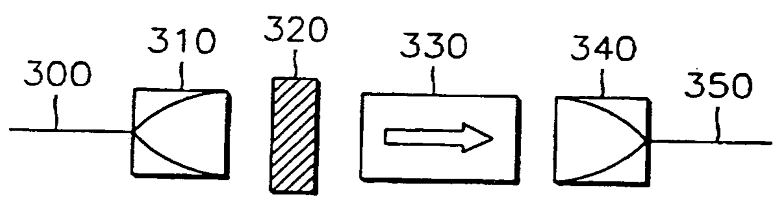


FIG. 4

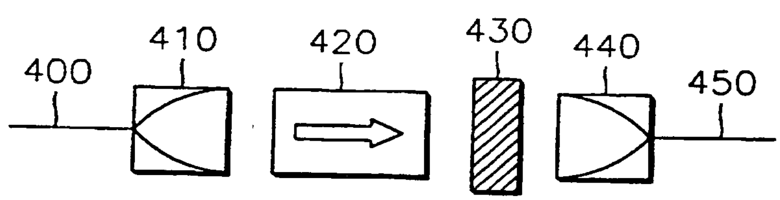


FIG. 5

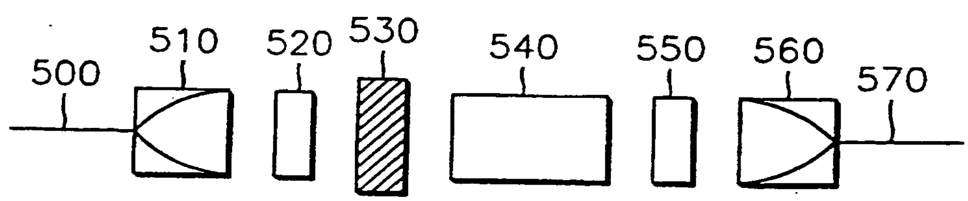
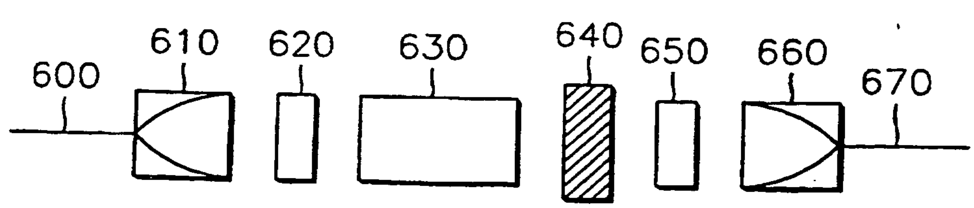


FIG. 6



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OPTICAL ATTENUATING ISOLATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical component which is used for optical transmission, and more particularly, to an optical component formed by combining an optical attenuator and an isolator, the optical component used as a module.

2. Description of the Related Art

In an optical network, many cases, particularly, a wavelength division multiplexing (WDM) system, use an optical attenuator to equalize optical power. However, when the optical attenuator is used, back reflection may cause a problem. Thus, an isolator is installed to the rear of the attenuator to prevent generation of this problem.

However, the use of the isolator causes several undesirable effects such as additional insertion loss, complexity of a device due to additional component use, and an increase in the additional material costs.

Upon establishment of an optical network, when an optical attenuator and an isolator are connected to each other in series, insertion loss that is the sum of the insertion losses of the two optical devices, is generated. In particular, an optical add drop multiplexer requires as many optical attenuators and isolators as the number of channels, thus increasing the total size of the apparatus.

Also, when an optical attenuator is used without isolators, the back reflection of the optical attenuator is highly likely to cause problems in optical signal transmission.

SUMMARY OF THE INVENTION

According to an aspect of the present invention an optical attenuating isolator is provided, including: a first collimator connected to a first optical transmission medium, the first collimator for collimating light received via the first optical transmission medium; an optical attenuating

filter for attenuating the output light of the first collimator; an isolation unit for receiving light attenuated by the optical attenuating filter and passing only polarized light which flows in a predetermined specific polarization direction; and a second collimator connected to a second optical transmission medium, the second collimator for collimating polarized light which has passed through the isolation unit, and transmitting the resultant light to the second optical transmission medium.

According to another aspect of the present invention an optical attenuating isolator is provided, including: a first collimator connected to a first optical transmission medium, the first collimator for collimating light received via the first optical transmission medium; an isolation unit for receiving the output light of the first collimator and passing only polarized light which flows in a predetermined specific polarization direction; an optical attenuating filter for attenuating polarized light which has passed through the isolation unit; and a second collimator connected to a second optical transmission medium, the second collimator for collimating polarized light which has passed through the optical attenuating filter, and transmitting the resultant light to the second optical transmission medium.

According to still another aspect of the present invention an optical attenuating isolator is provided, including: a polarizer for passing only light which is polarized in a direction that is the same as the direction of polarization of the polarizer, among the received light; an optical attenuating filter for attenuating polarized light which has passed through the polarizer; a Faraday rotator for rotating attenuated light which has passed through the optical attenuating filter, a predetermined number of degrees; and an analyzer for passing only light which is polarized in a direction that is the same as the direction of the analyzer, among the rotated light.

According to yet another aspect of the present invention an optical attenuating isolator is provided, including: a polarizer for passing only light which is polarized in a direction that is the same as the direction of polarization of the polarizer, among the received light; a Faraday rotator for rotating polarized light which has passed through the polarizer, a

predetermined number of degrees; an optical attenuating filter for attenuating light which has passed through the Faraday rotator; and an analyzer for passing only light which is polarized in a direction that is the same as the direction of the analyzer, among the light received from the optical attenuating filter.

An advantage of the present invention is the provision of an optical attenuating isolator which can perform both an attenuation function and an isolation function.

BRIEF DESCRIPTION OF THE DRAWINGS

The above advantage of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a block diagram illustrating the configuration of an isolator;

FIG. 2 is a block diagram illustrating the configuration of a variable optical attenuator;

FIG. 3 is a block diagram illustrating the configuration of an optical attenuating isolator which performs both optical attenuation and isolation, according to an embodiment of the present invention;

FIG. 4 is a block diagram illustrating the configuration of an optical attenuating isolator which performs both optical attenuation and isolation, according to another embodiment of the present invention;

FIG. 5 is a block diagram illustrating the configuration of an optical attenuating isolator which performs both optical attenuation and isolation, according to still another embodiment of the present invention;

FIG. 6 is a block diagram illustrating the configuration of an optical attenuating isolator which performs both optical attenuation and isolation, according to yet another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Isolators cause low loss with respect to light transmitted in a normal direction from an input projection terminal to an output terminal, and high loss with respect to light transmitted in the reverse direction to the normal

direction, in order to prevent light from flowing backward and from recombining. Therefore, isolators are optical components for stabilizing the operation of a system.

An isolator shown in FIG. 1 includes a first collimator 100, a polarizer 110, a Faraday rotator 120, an analyzer 130, and a second collimator 140. The polarizer 110 and the analyzer 130 are rotated 45° with respect to each other, and keep this relative position.

In the operation principle of isolators, isolators transmit only specific polarized light in one direction, and prevent the passage of polarized light in a direction that is perpendicular to the direction of the polarized light.

The Faraday rotator 120 rotates incident polarized light by 45°. Light reflected by the output terminal of the isolator enters the rear side of the Faraday rotator 120, and is again rotated 45°. Consequently, the reflected light is rotated 90° with respect to the incident light. Hence, the 90°-rotated reflected wave is blocked by the polarizer 110. Here, the Faraday rotator 120 uses a Faraday effect in which the polarized surface of light is rotated while the light passes through a magneto-optic material.

FIG. 2 shows a variable optical attenuator. Referring to FIG. 2, the variable optical attenuator includes a first collimator 200, a linear variable neutral density filter 210, and a second collimator 220. The first collimator 200 receives light from an optical fiber, collimates the received light, and transmits the collimated light to the linear variable neutral density filter 210. The linear variable neutral density filter 210 variably attenuates the collimated light and transmits the resultant light to the second collimator 220. The second collimator 220 collimates the attenuated light to an optical fiber.

The variable optical attenuator can constantly attenuate optical signals through the above-described operation. The intensity of this attenuation is variable. The variable optical attenuator is used for measurement of the characteristics of an optical communications system.

FIG. 3 shows an optical attenuating isolator according to an embodiment of the present invention, which includes a first optical transmission medium 300, a first collimator 310, an optical attenuating filter

320, an isolation unit 330, a second collimator 340, and a second optical transmission medium 350. Light is applied to the first collimator 310 via the first optical transmission medium 300 which is an optical fiber or a waveguide.

The first collimator 310 collimates received light, and transmits the collimated light to the optical attenuating filter 320. The optical attenuating filter 320 can variably attenuate the collimated light. The degree of this attenuation can be controlled by turning a screw which is installed on the exterior of the optical attenuating isolator module according to the present invention. The attenuated light is transmitted to the isolation unit 330.

The isolation unit 330 includes a polarizer, a Faraday rotator, and an analyzer. Thus, the isolation unit 330 passes only specific polarized light in a direction which is the same as the predetermined direction of polarization to be performed by the polarizer, and prevents the passage of polarized light which flows perpendicular in relation to the polarization direction. Light which has passed through the isolation unit 330 is collimated by the second collimator 340, and the resultant light is transmitted to the second optical transmission medium 350.

FIG. 4 shows an optical attenuating isolator according to another embodiment of the present invention, which includes a first optical transmission medium 400, a first collimator 410, an isolation unit 420, an optical attenuating filter 430, a second collimator 440, and a second optical transmission medium 450.

The embodiment shown in FIG. 4 is the same as that shown in FIG. 3 except that the positions of the optical attenuating filters 320 and 430 are different. That is, in the embodiment shown in FIG. 4, the optical attenuating filter 430 is positioned to the rear of the isolation unit 420. On the other hand, in the embodiment shown in FIG. 3, the optical attenuating filter 320 is positioned in front of the isolation unit 330. Hence, attenuation before isolation, as shown in FIG. 3, is compared with attenuation after isolation, as shown in FIG. 4. The optical attenuating isolator of FIG. 3 or 4 can be manufactured according to the convenience of a process for manufacturing the optical attenuating isolator.

FIG. 5 shows an optical attenuating isolator according to still another embodiment of the present invention, which includes a first optical transmission medium 500, a first collimator 510, a polarizer 520, an optical attenuating filter 530, a Faraday rotator 540, an analyzer 550, a second collimator 560, and a second optical transmission medium 570. The embodiment shown in FIG. 5 is obtained by further installing an optical attenuating filter between the components constituting the isolation unit 330 or 420 shown in FIG. 3 or 4.

The characteristics of the embodiment shown in FIG. 5 will now be described. In the embodiment shown in FIG. 3 or 4, the isolation unit 330 or 420 performs independent isolation. On the other hand, in the embodiment shown in FIG. 5, a filter is installed between the components of the isolation unit, and performs attenuation before or after the operation of each isolator component.

In FIG. 5, light is applied to the first collimator 510 via the first optical transmission medium 500 which is an optical fiber or a waveguide. The first collimator 510 collimates received light and transmits the collimated light to the polarizer 520. The polarizer 520 selectively passes only light beams which flow in a direction which is the same as its polarization direction, among received light beams.

The optical attenuating filter 530 can variably attenuate the polarized light. The degree of this attenuation can be controlled by turning a screw which is installed on the exterior of the optical attenuating isolator module according to the present invention. The attenuated light is applied to the Faraday rotator 540. The Faraday rotator 540 rotates received light by 45° in an existing polarization direction. The 45°-rotated light is applied to the analyzer 550. Only polarized light flowing in a direction that is the same as the polarization direction of the analyzer 550, passes through the analyzer 550.

The second collimator 560 collimates the polarized light which has passed through the analyzer 550, and transmits the resultant light to the second optical transmission medium 570.

FIG. 6 shows an optical attenuating isolator according to yet another embodiment of the present invention, which includes a first optical transmission medium 600, a first collimator 610, a polarizer 620, a Faraday rotator 630, an optical attenuating filter 640, an analyzer 650, a second collimator 660, and a second optical transmission medium 670.

The embodiment shown in FIG. 6 is the same as that shown in FIG. 5 except that the optical attenuating filter 640 is installed behind the Faraday rotator 630. Likewise, the optical attenuating isolator of FIG. 5 or 6 will be able to be selectively manufactured according to the convenience of a manufacturing process.

In the above-described configurations according to the embodiments, the function of variable optical attenuation can be performed by controlling a linear variable neutral density filter, and simultaneously, the function of isolation can be performed using first and second collimators, a polarizer, a Faraday rotator, and an analyzer. Consequently, optical attenuating isolators according to the present invention are capable of variably determining the degree of optical attenuation.

According to the present invention, an optical attenuator and an isolator are configured into a module, such that insertion loss can be reduced, and that the number of optical transmission media used is reduced, thus preventing generation of loss caused by the optical transmission media. Also, an optical attenuating isolator according to the present invention is used as an optical attenuator for an optical communications system having directivity, such that a deterioration of light of the optical communications system due to back reflection can be prevented, and that the degree of attenuation can be controlled.

What is claimed is:

1. An optical attenuating isolator comprising:

a first collimator connected to a first optical transmission medium, the first collimator for collimating light received via the first optical transmission medium;

an optical attenuating filter for attenuating the output light of the first collimator;

an isolation unit for receiving light attenuated by the optical attenuating filter and passing only polarized light which flows in a predetermined specific polarization direction; and

a second collimator connected to a second optical transmission medium, the second collimator for collimating polarized light which has passed through the isolation unit, and transmitting the resultant light to the second optical transmission medium.

2. The optical attenuating isolator of claim 1, wherein the optical attenuating filter can variably control its attenuation with respect to the received light.

3. The optical attenuating isolator of claim 1, wherein the isolation unit comprises:

a polarizer for passing only light which is polarized in a direction that is the same as the direction of polarization of the polarizer, among the received light;

a Faraday rotator for rotating a predetermined number of degrees light which has passed through the polarizer; and

an analyzer for passing only light which is polarized in a direction that is the same as the direction of the analyzer, among the rotated light.

4. An optical attenuating isolator comprising:

a first collimator connected to a first optical transmission medium, the first collimator for collimating light received via the first optical transmission medium;

an isolation unit for receiving the output light of the first collimator and passing only polarized light which flows in a predetermined specific polarization direction;

an optical attenuating filter for attenuating polarized light which has passed through the isolation unit; and

a second collimator connected to a second optical transmission medium, the second collimator for collimating polarized light which has passed through the optical attenuating filter, and transmitting the resultant light to the second optical transmission medium.

5. The optical attenuating isolator of claim 4, wherein the optical attenuating filter can variably control its attenuation with respect to the received light.

6. The optical attenuating isolator of claim 4, wherein the isolation unit comprises:

a polarizer for passing only light which is polarized in a direction that is the same as the direction of polarization of the polarizer, among the received light;

a Faraday rotator for rotating a predetermined number of degrees light which has passed through the polarizer; and

an analyzer for passing only light which is polarized in a direction that is the same as the direction of the analyzer, among the rotated light.

7. An optical attenuating isolator comprising:

a polarizer for passing only light which is polarized in a direction that is the same as the direction of polarization of the polarizer, among the received light;

an optical attenuating filter for attenuating polarized light which has passed through the polarizer;

a Faraday rotator for rotating attenuated light which has passed through the optical attenuating filter, a predetermined number of degrees; and

an analyzer for passing only light which is polarized in a direction that is the same as the direction of the analyzer, among the rotated light.

8. The optical attenuating isolator of claim 7, wherein the optical attenuating filter can variably control its attenuation with respect to the received light.

9. The optical attenuating isolator of claim 7, further comprising:

a first collimator connected to a first optical transmission medium, the first collimator for collimating light received via the first optical transmission medium and transmitting collimated light to the polarizer; and

a second collimator connected to a second optical transmission medium, the second collimator for collimating light which has passed through the analyzer, and transmitting the resultant light to the second optical transmission medium.

10. An optical attenuating isolator comprising:

a polarizer for passing only light which is polarized in a direction that is the same as the direction of polarization of the polarizer, among the received light;

a Faraday rotator for rotating polarized light which has passed through the polarizer, a predetermined number of degrees;

an optical attenuating filter for attenuating light which has passed through the Faraday rotator; and

an analyzer for passing only light which is polarized in a direction that is the same as the direction of the analyzer, among the light received from the optical attenuating filter.

11. The optical attenuating isolator of claim 10, wherein the optical attenuating filter can variably control its attenuation with respect to the received light.

12. The optical attenuating isolator of claim 10, further comprising:

a first collimator connected to a first optical transmission medium, the first collimator for collimating light received via the first optical transmission medium and transmitting collimated light to the polarizer; and

a second collimator connected to a second optical transmission medium, the second collimator for collimating light which has passed through the analyzer, and transmitting the resultant light to the second optical transmission medium.

13. An optical attenuating isolator substantially as hereinbefore described with reference to and/or as illustrated in Figure 3 of the accompanying drawings.

14. An optical attenuating isolator substantially as hereinbefore described with reference to and/or as illustrated in Figure 4 of the accompanying drawings.

15. An optical attenuating isolator substantially as hereinbefore described with reference to and/or as illustrated in Figure 5 of the accompanying drawings.

16. An optical attenuating isolator substantially as hereinbefore described with reference to and/or as illustrated in Figure 6 of the accompanying drawings.

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Application No:	GB 0000616.3	**Examiner:**	Tony Reevell
Claims searched:	1 to 16	**Date of search:**	5 April 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G2F (FCM, FSX); G2J (JGAT)

Int Cl (Ed.7): G02F1/09

Other: Online: EPODOC; WPI; PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	JP 090210857 A	(SHINJI et al.) - see figure 1 and abstract	1,2,3,4,5,6
X	JP 080128806 A	(KOHEI) - see figure 1 and abstract	1,3,4,6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 25 6118

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	GB 2 345 761 A (SAMSUNG ELECTRONICS CO LTD) 19 July 2000 (2000-07-19) * the whole document * ---	1-10	G02F1/09 G02F1/01 G02B6/26
A	MUNIN E: "ANALYSIS OF A TUNABLE BANDPASS FILTER BASED ON FARADAY ROTATORS" IEEE TRANSACTIONS ON MAGNETICS, IEEE INC. NEW YORK, US, vol. 32, no. 2, 1 March 1996 (1996-03-01), pages 316-319, XP000555498 ISSN: 0018-9464 * figure 1 * ---	1-10	
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 252 (P-1367), 9 June 1992 (1992-06-09) & JP 04 060511 A (NIPPON TELEGR & TELEPH CORP), 26 February 1992 (1992-02-26) * abstract; figures 1-6 * ---	1-10	
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 04, 30 April 1999 (1999-04-30) & JP 11 002781 A (TDK CORP), 6 January 1999 (1999-01-06) * abstract; figure 1 * -----	1-10	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G02F G02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	14 January 2003	Frank, W

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document